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# UPGRADE OF PREPARATION OF BATCH MIXED WITH CULLET IN MELTING ELECTROVACUUM GLASS

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The industrial practice of producing electrovacuum glass with periodical changes in glass compositions is considered.

To satisfy changing the requirements of the contemporary TV and electronic industries, glass factories have to adapt to periodic production of electrovacuum glass with different light transmission and to continuously refine glass quality. The solution of these problems is related to certain specifics of preparing mixtures of batch with cullet. The production of TV screens with two different transmission coefficients generates three varieties of cullet: dark-colored, light-colored, and intermediate cullet formed during a transition from dark electrovacuum glass to light glass and vice versa. To produce glass with a constant preset transmission coefficient, it is necessary to store different cullet varieties in different hoppers and to ensure their precise proportioning with batch components.

The size of cullet particles is significant for melting and homogenization processes. In the past, cullet with particle size around 70 mm used to be regarded as quite acceptable, whereas now acceptable cullet should have a particle size not larger than 30 mm. This decreased size of cullet particles is related to the fact that a mixture of cullet and batch is fed into the tank furnace hopper via a screw feeder, which contributes to maintaining a more uniform glass-melting thermal regime, a more constant melt level in the tank furnace, and decreased erosion of refractories. Yet, on the other hand, cullet particles should not be too small so as not to impede the batch melting process [1].

Based on industrial experience, we propose the following scheme for preparing cullet with different light transmission (Fig. 1).

Initial (untreated) cullet placed in buckets arrives at the batch preparation site and comes into the hopper for initial cullet. Rejected TV screens (after annealing, sorting, etc.) arrived at the same hopper. From the hopper the material goes to a jaw crusher for primary crushing and, via vibration feeder *5*, through a permanent magnetic separator that collects fixtures and other metal inclusions, then to a rotor crusher. Here glass waste is ground to the desired particle size (30 mm), then via vibration feeder *8* it is fed into an elevator, and via a chute is channeled to conveyor belt *11*. Cullet lumps on the belt pass beneath the magnetic separator and the all-metal detector and drop into the hopper for treated cullet. Magnetic metallic inclusions can be relatively easily removed by magnetic separation of glass cullet, whereas nonmagnetic inclusions are removed using electromagnetic separators (called "all-metal separators") [2]. Upon detecting nonmagnetic metal inclusions in a cullet lump, the detector gate at the end of the conveyor is put into motion and the glass with metal inclusions is channeled to the waste hopper.

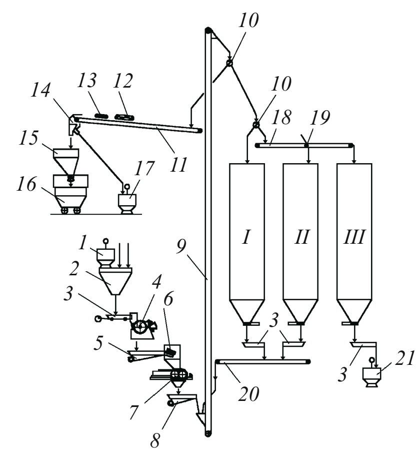


**Fig. 1.** Technological scheme of preparing cullet with different light transmission: *1*) bucket with cullet; *2*) hopper with initial cullet; *3*) plunger feeder; *4*) jaw crusher; *5*, *8*) vibration feeders; *6*) magnetic separator; *7*) rotor crusher; *9*) elevator; *10*) switch reversing cullet feeding; *11*, *20*) conveyor belts; *12*) belt magnetic separator; *13*) detector for metallic impurities; *14*) gate; *15*) hopper for treated cullet; *16*) car; *17*) hopper for glass with metal; *18*) conveyor; *19*) tripper; *21*) bucket; *I*, *II*, and *III*) spare hoppers for light-colored, dark-colored, and intermediate cullet, respectively.

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This method ensures the removal of metallic inclusions from cullet.

If the amount of cullet is larger than required for production, switches for reversing feeding directions are put in the required position, and cullet from the elevator goes to a spare hopper for light or dark glass.

In the case where the glass composition and transmission coefficient change, cullet from the elevator is sent to belt conveyor *18* and then to the spare hopper for transitional cullet (with variable colorant content). After the end of the transition period, in which light transmission varies, cullet from spare hopper *III* with varying light transmission can be used in production by mixing small quantities of it with industrial waste in the initial cullet hopper.

To decrease the abrasive effect of cullet particles on the inner surface of the hoppers, such cullet should be stored in the main flow hoppers with a flat funnel. The walls of such hopper are protected from the abrasive effect of the cullet flow during its loading and unloading; accordingly, glass melt is less contaminated with metal impurities [2].

The amount of pigments has a great effect on the light transmission of glass. Nickel and cobalt oxides are currently used to impart a neutral tint to glass used for color kinescope screens. The colorants are introduced into a glass melt both via the batch components and via cullet. Therefore, to produce glass with precisely specified light transmission, it is necessary to precisely proportion batch components and cullet on scales taking into account their content of pigments.

The quality of mixing batch components and batch with cullet is essential for accelerating the melting and homogenization processes. The batch components get sufficiently well mixed in a fast mixer, first in the dry state, then in the moistened state, whereas a mechanical mixer cannot be used for mixing batch with cullet, for the risk of premature wear of the mixer and contamination of the initial mixture with metal impurities.

In the past, the batch for electrovacuum glass was never mixed with cullet; a mixed batch was just loaded on top of a certain amount of cullet. At that time glass had a constant level of light transmission and the content of pigments in the batch and cullet remained constant as well; therefore, precise proportioning of cullet was not necessary. Now glass with different light transmission is produced and manufacturers have to use cullet with different contents of colorants; therefore, it has become necessary to mix batch with cullet in order to ensure its homogenous distribution in the glass volume. At present, partial mixing of precisely proportioned quantities of batch and cullet is performed during their charging into the bucket. Screw feeders used in the tank furnace also contribute to mixing batch with cullet. Figure 2 shows a technological scheme of mixing batch with cullet, which allows for simultaneously using different varieties of cullet.

Prepared cullet is transported to the proportioning-mixing division and placed in the hopper for the main cullet flow. To ensure simultaneous precise proportioning of cullet varieties with different light transmission values, we propose using two separate hoppers.

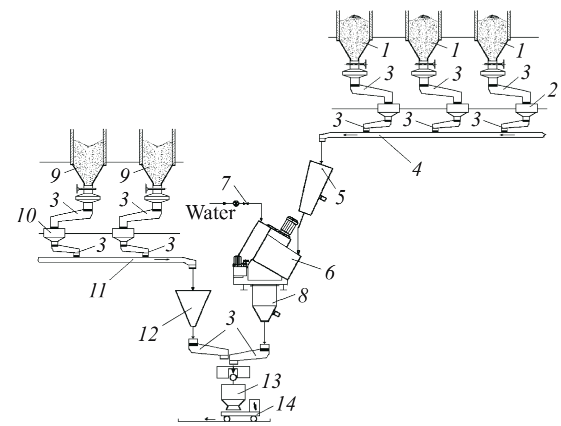


**Fig. 2.** Technological scheme of mixing batch with cullet: *1* ) hoppers for material components; *2* ) automatic scale for batch components; *3* ) vibration feeder; *4*, *11* ) belt conveyors; *5* ) intermediate hopper for proportioned batch materials before mixing; *6* ) fast-speed mixer; *7* ) water proportioning device; *8* ) lower hopper of the mixer; *9* ) hopper for main cullet flow; *10* ) electron scale for cullet; *12* ) intermediate hopper for weighed cullet; *13* ) bucket; *14* ) car.

Vibration feeders deliver batch components from the hopper to an automatic scale. Similar feeders deliver weighed portions of components onto conveyor belt *4*, which channels the batch components to the intermediate hopper of the mixer. When the gate of the intermediate hopper opens, the batch components penetrate into the high-speed mixer. Mixing is implemented in two cycles: first the dry and then the moistened batch. After the first cycle, the water-proportioning device charges a required quantity of water into the mixture to moisten the batch. After the completion of the entire mixing cycle, the batch arrives at the lower hopper of the mixer. Simultaneously with batch mixing, cullet is proportioned. Prepared cullet is transported from the main flow hoppers using a vibration feeder to the electronic scale where its quantity is proportioned according to the prescribed formula. The weighed cullet portions on belt conveyor *11* via the intermediate hopper using the vibration feeder are brought to the bucket. The beginning of cullet weighing coincides with the beginning of the second cycle of batch mixing, When the car with the bucket stops at a prescribed place, the vibration feeder is switched on. First the batch is loaded into the bucket and a few seconds later cullet is loaded as well. Subsequently, the simultaneous loading of batch and cullet into the bucket ensures their mixing.

During the discharge of batch hoppers, mixing in the high-speed mixer, and transportation of prepared batch mixture, one should take all possible measures to prevent stratification of individual components of the mixture. This is facilitated by:

– using mass flow hoppers for individual components [2];

– decreasing the drop path of a batch mixture with components of different densities;

– preventing the use of vibration devices for unloading batch hoppers;

– using materials whose grain sizes differ insignificantly [2];

– a tower-like layout of hoppers of the proportioning-mixing division, where materials after each proportioning can be directly fed into the mixer, which helps to avoid excessive batch transportation and dusting [3];

– decreasing the distance of transportation for buckets with mixtures of batch with cullet.

Such organization of the production process involving cullet with different contents of colorants and, accordingly, different transmission coefficients makes it possible to produce high-quality electrovacuum glass.

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